A Survey of the Condition of Streams in the Primary Region of Mountain Top Removal / Valley Fill Coal Mining

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1.	**Project Name:**	A Survey of the Condition of Streams in the Primary Region of Mountain Top Removal/ Valley Fill Coal Mining
2.	**Project Requested by:**	William Hoffman Environmental Services Division USEPA, Philadelphia, PA
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4.	**Date of Project Initiation:**	March 1999
5.	**Project Officer:**	Jim Green, Aquatic Biologist USEPA, Wheeling, West Virginia
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7. Project Description:

A. Objective and Scope

A typical mountain top removal/valley fill (MTR/VF) mining operation in the Appalachian coal fields removes overburden and interburden material to facilitate the extraction of coal. Excess spoils are often placed in adjacent valleys containing first and second order streams. The effect of these mining operations on the biological condition of downstream reaches is uncertain.

This project will supplement existing data on stream condition downstream of MTR/VF operations. The study has three objectives:

- Characterize and compare conditions in three categories of streams: 1) streams that are not mined; 2) streams in mined areas with valley fills; and 3) streams in mined areas without valley fills.
- Characterize conditions and describe any cumulative impacts that can be detected in streams downstream of multiple fills.
- Characterize conditions in sediment control structures (ditches) on MTR/VF operations.

This study will use measures of the benthic macroinvertebrate assemblage composition, structure and function; physical stream habitat assessments; current velocity; limited field chemistry parameters; a quantitative estimate of substrate size; and water temperature data logger measurements to characterize stream condition at these sites.

In addition we will collect quantitative benthic macroinvertebrate samples using a Surber sampler at six sites. The USEPA has agreed to collect these samples. These samples will be stored at the USEPA Biology Unit in Wheeling, West Virginia, until funds are secured to process and analyze the samples and interpret the data to estimate secondary production measurements. It is outside the scope of this project to process or analyze the samples and interpret the quantitative data.

The study will provide data and information for the Programmatic Environmental Impact Statement (PEIS). The PEIS will be final in December 2000. Most of this project will be completed by the Spring of 2000 so that the findings can be incorporated into the draft PEIS. Four sampling periods will be completed during this project (Spring 1999, Summer 1999, Fall 1999 and Winter 2000).

B. Data Usage

This section describes the stream indicators and how the data will be used in the assessment of stream condition. For descriptions of methods, sampling frequencies, preservatives, etc., see Section D.

The benthic macroinvertebrate data, physical habitat assessments, current velocity, field chemistry measurements, substrate size characterizations, and water temperature data logger measurements will be used to develop a synoptic description of stream conditions in the primary region of MTR/VF operations for the four separate seasons.

The sampling sites are located in unmined watersheds, mined watersheds with valley fills, and mined watersheds without valley fills. The mined watersheds with valley fills represent a gradient of attributes including the number of fills, size of fills, age of fills, and the percentage of the total watershed filled. The mined watersheds without valley fills also represent various conditions (e.g. old contour mining and underground mines). The measurements of stream condition will be compared to the watershed mining attributes to explore any relationship between stream condition and those attributes.

Semi-Quantitative Benthic Macroinvertebrate Samples

Benthic macroinvertebrate samples will be collected using a semi-quantitative method (see Section D). The organisms will be identified to the family level. The benthic macroinvertebrate data will be used as the direct and primary indicator of stream ecological health. The benthic population integrates stressors over time, integrates the effects of multiple stressors and is impacted by both chemical stressors and habitat degradation. Some benthic organisms live in the stream for periods of one year and longer.

Benthic macroinvertebrate taxa lists and metric values will be analyzed to determine the condition of all sites. The data from the mined sites will be grouped and compared to the biometric values from the group of unmined sites to determine impacts from the MTR/VF operations. The mined sites will also be paired to the unmined sites based on the watershed proximity, watershed area and elevation, and the individual pairs of sites will also be compared.

USEPA biologists will work with WV DEP biologists to identify other reference sites and sources of data that might be used for comparison and evaluation of stream conditions.

Some sites were chosen on larger streams where MTR/VF operations could be bracketed by upstream and downstream sites (e.g. Mud River). Control sites in the larger streams, upstream of large MTR/VF operations will be compared to sites downstream of the operations to determine whether there are any significant differences between the upstream control site and the site downstream of the mining operations. We do not refer to the control sites on larger streams as “reference” sites, because the term “reference” implies minimal impairment. Some of the sites upstream of the MTR/VF operations are subject to other sources of impairment in the headwaters (e.g. residential development).

Although it is not the primary objective of this study to compare individual sites to each other, an estimate of precision will be made to help determine significant differences between individual sites. The estimate of precision will be based on replicate samples. Any difference in metric values between sites that is larger than the estimate of method precision will be considered a significant difference. Analysis of the actual values of the metrics, based on the biometric values at unmined sites and possible other reference values, will determine whether the difference indicates impairment of the aquatic community.

The watersheds represent a gradient of conditions in terms of the age of fills, size of fills, number of fills, and the percentage of the watershed filled. To the extent possible, relationships between these attributes and the benthic community condition will be explored.

Quantitative Benthic Macroinvertebrate Samples

We will collect quantitative benthic macroinvertebrate samples using a Surber sampler at six sites. The USEPA has agreed to collect these samples. These samples will be stored at the USEPA Biology Unit in Wheeling, West Virginia, until funds are secured to process and analyze the samples and interpret the data to estimate secondary production measurements. It is outside the scope of this project to process or analyze the samples and interpret the quantitative data. This project will not use the quantitative data to estimate secondary production. If funds are secured to process the quantitative samples, this project may compare the quantitative data to the semi-quantitative data collected at the same sites to determine whether the two sampling methods concur on overall stream condition.

Physical Habitat Evaluations

Physical habitat parameters will be described and assessed using USEPA Rapid Bioassessment Protocols (RBP) (USEPA, 1999). The habitat evaluations will be used to document status and changes in physical habitat including the width of the riparian vegetation zone, sediment deposition and bank condition (see Section D and Appendix B for a complete list of habitat parameters and methods). The habitat data will be evaluated using the RBP definitions of optimal, suboptimal, marginal and poor. Parameter scores in the optimal or suboptimal range indicate adequate habitat is available in the stream reach. Parameter scores in the marginal or poor range indicate degradation of the stream habitat could be limiting the aquatic communities within the stream reach. The habitat data will be used to characterize the condition of the sites, and to indicate whether impaired physical habitat could be limiting the benthic community.

Current Velocity

Current velocity will be measured in the riffle where the benthic macroinvertebrate samples are collected. The current velocity will be used to characterize the micro habitats in riffles at the different sites, created by different current velocities.

Field Measurements of Water Chemistry

Streams will be sampled for dissolved oxygen, conductivity, pH and temperature in the field, in situ. These measurements are routinely taken when benthic samples are collected and can provide some information on differences in water quality between sites.

Quantitative Substrate Size Characterization

The substrate size characterization will be used to indicate differences in substrate size composition between mined and unmined sites within a watershed and unmined sites between watersheds. Substrate size is often a limiting factor for benthic macroinvertebrate assemblages. Cobble-sized substrate provides the greatest amount of usable habitat to benthic macroinvertebrates. Smaller substrate can reduce the amount of interstices and habitat available for colonization. During reconnaissance work, we observed that some of the watersheds seem to have different substrate size compositions. These data will provide a quantitative estimate of substrate size composition.

Water Temperature Data Logger Measurements

Data loggers will be used to record in-stream temperature every two hours for the period October 1999 to July 2000, if flows allow. The data will be processed semi-annually, so only those data collected between the Fall 1999 and Spring 2000 will be available for the draft PEIS in the spring of 2000. The data loggers will be left in-stream at the six sites following the Spring 2000 sampling event, so that additional data could be retrieved and included in the final PEIS.

These data will be used to compare temperature variations in-stream at the mined sites compared to the unmined sites. Changes in temperature variations could affect the benthic macroinvertebrate communities.

C. Monitoring Design and Rationale

Monitoring sites were chosen to meet the objectives of the study as outlined above. The monitoring sites, stream name, watershed name, approximate location and approximate description of mining activity upstream of the sites are provided in Table 1. Additional information on the sites is provided in Appendix 1. The term “inactive mining” means no current extraction is occurring to our knowledge.

Note that the station numbers in Table 1 are not sequential. The thirty-seven (37) benthic sampling sites were chosen from a larger pool of candidate sampling sites (a total of 127 sites). The station numbers in the original larger set of candidate sites were retained since the other sites may be sampled for chemistry as part of the PEIS.

This survey was designed to provide a synoptic description of stream conditions in five watersheds across the primary MTR/VF region. These watersheds are Twentymile Creek, Clear Fork, Island Creek, Mud River and Spruce Fork. Within each watershed, two arrays of streams were selected by staff familiar with the mining operations in the watershed (primarily WV DEP mining inspectors and the Streams Workgroup working on the PEIS). One stream array in each watershed is unmined. The other stream array in each watershed contains significant MTR/VF operations. The MTR/VF operations represent a gradient of number and size of fills, type of fills, and age of fills. We used a paired-watershed approach to locating some of the sites so that some of the unmined and mined sites within a watershed would be similar in terms of approximate watershed area and elevation. In addition, a few sites have mining activity in the upstream watershed, but no valley fills.

We considered several sediment control structures as candidate monitoring sites. However, many of the sites were not reconstructed streams, but ponds or dry ditches filled with boulder-sized rip-rap. Only one sediment control structure was identified as having flowing water and could be sampled using the dnet. This site will be sampled during all four seasons, flow permitting. Since only one such site will be sampled, this study will provide only limited information to meet the third objective of the study (to characterize conditions in sediment control structures on MTR/VF operations).

Site locations may be changed or new stations may be added during the study period . All changes and additions will be described in the PEIS.

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT01	Mud River	Mud River	Approximately 650 feet downstream of confluence with Rushpatch Branch.	Upstream control for Mud River. Minimal inactive mining upstream.
MT02	Rushpatch Branch	Mud River	Approximately 500 feet upstream of confluence with Mud River.	Unmined
MT03 *	Lukey Fork	Mud River	Approximately 1 mile upstream of confluence with Mud River.	Unmined
MT13	Spring Branch of Ballard Fork	Mud River	Approximately 585 feet upstream of confluence with Ballard Fork.	Unmined
MT14	Ballard Fork	Mud River	Approximately 900 feet upstream of confluence with Mud River	Active mining. Site is downstream of 8 valley fills.
MT15 *	Stanley Fork	Mud River	Approximately 700 feet upstream of confluence with Mud River.	Inactive mining. Site is downstream of 6 valley fills.
MT18	Sugartree Branch	Mud River	Approximately 2000 feet upstream of confluence with Mud River.	Inactive mining. Site is downstream of 2 valley fills.
MT23	Mud River	Mud River	Approximately 1300 feet downstream of confluence with Connelly Branch.	Cumulative downstream site for Mud River. Downstream of active mining and 26 valley fills.

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT24	Stanley Fork	Mud River	Stanley Fork Drainage, Sediment Control Structure	Inactive mining. Site is located in a sediment control structure on top of fill.
MT25B *	Rockhouse Creek	Spruce Fork	Approximately 1.2 miles upstream of confluence with Spruce Fork. Downstream of pond.	Inactive mining. Site is downstream of 1 valley fill.
MT32	Beech Creek	Spruce Fork	Approximately 1.9 miles upstream of confluence with Spruce Fork.	Inactive mining. Site is downstream of 5 valley fills.
MT34B	Left Fork of Beech Creek	Spruce Fork	Approximately 900 feet upstream of confluence with Beech Creek. Downstream of pond.	Active mining. Site is downstream of 1 valley fill.
MT39 *	White Oak Branch	Spruce Fork	Approximately 2000 feet upstream of confluence with Spruce Fork.	Unmined
MT40	Spruce Fork	Spruce Fork	In Blair, directly upstream of confluence with White Trace Branch.	Upstream control for Spruce Fork. Downstream of inactive mining and 9 valley fills, including 2 refuse fills.
MT42	Oldhouse Branch	Spruce Fork	Approximately 2400 feet upstream of confluence with Spruce Fork.	Unmined

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT45	Pigeonroost Branch	Spruce Fork	Approximately 4500 feet upstream of confluence with Spruce Fork.	Inactive Mining. No valley fills.
MT48	Spruce Fork	Spruce Fork	Approximately 5100 feet downstream of confluence with Beech Creek.	Cumulative downstream site for Spruce Fork. Downstream of active mining and 22 valley fills.
MT50	Cabin Branch	Island Creek	Approximately 650 feet upstream of confluence with Jack's Fork.	Unmined
MT51	Cabin Branch	Island Creek	Approximately 1800 feet upstream of confluence with Copperas Mine Fork.	Unmined
MT52	Cow Creek	Island Creek	Approximately 3 miles upstream of confluence with Left Fork.	Upstream control for Cow Creek, but is influenced by inactive mining.
MT55	Cow Creek	Island Creek	Approximately 1000 feet downstream of confluence with Left Fork.	Cumulative downstream site for Cow Creek. Site is downstream of inactive mining and 4 valley fills.
MT57B	Hall Fork	Island Creek	Approximately 3600 feet upstream of Left Fork. Downstream of pond effluent.	Inactive mining. Site is downstream of 1 valley fill.

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT60	Left Fork	Island Creek	Approximately 5000 feet upstream of confluence with Cow Creek.	Inactive mining. Site is downstream of 2 valley fills.
MT62	Toney Fork	Clear Fork	Approximately 300 feet downstream of confluence with Buffalo Fork.	Inactive mining. Site is downstream of 10 valley fills.
MT64 *	Buffalo Fork	Clear Fork	Approximately 4900 feet upstream of confluence with Toney Fork.	Inactive mining. Site is downstream of 5 valley fills.
MT69 *	Ewing Fork	Clear Fork	Approximately 2000 feet upstream of confluence with Toney Fork.	Inactive mining. No fills. This site is a candidate unmined site for Surber sampling, but field visit indicated elevated conductivity.
MT75	Toney Fork	Clear Fork	Approximately 700 feet downstream of Reeds Branch.	Inactive mining. Site is downstream of 5 valley fills.
MT78	Raines Fork	Clear Fork	Approximately 400 feet upstream of confluence with Sycamore Creek.	Inactive mining. No fills.
MT79	Davis Fork	Clear Fork	Approximately 600 feet upstream of confluence with Sycamore Creek.	Unmined?

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT81 *	Sycamore Creek	Clear Fork	Approximately 500 feet upstream of confluence with Lem Fork.	Inactive mining. No fills. This site is a candidate unmined site for Surber sampling, but field visit revealed the site is downstream of a mine drainage treatment plant.
MT86	Rader Fork	Twentymile Creek	Approximately 500 feet upstream of confluence with Twentymile Creek.	Cumulative downstream site for Rader Fork. Inactive mining. Site is downstream of 3 valley fills.
MT87	Neff Fork	Twentymile Creek	Approximately 800 feet upstream of confluence with Rader Fork.	Inactive mining. Site is downstream of 3 valley fills and a mine drainage treatment plant.
MT91	Rader Fork	Twentymile Creek	Approximately 500 feet upstream of confluence with Neff Fork.	Upstream control for Rader Fork. Unmined
MT95	Neil Branch	Twentymile Creek	Approximately 500 feet upstream of confluence with Twentymile Creek.	Unmined
MT98	Hughes Fork	Twentymile Creek	Approximately 200 feet upstream of confluence with Jim's Hollow.	Inactive mining. Site is downstream of 8 valley fills.

Table 1. Station Locations and Descriptions				
Station Number	**Stream Name**	**Watershed**	**Approximate Locations**	**Description of Mining Activity Upstream**
MT103	Hughes Fork	Twentymile Creek	Approximately 2500 feet upstream of confluence with Jim's Hollow.	Inactive mining. Site is downstream of 6 valley fills.
MT104	Hughes Fork	Twentymile Creek	Approximately 1.3 miles upstream of confluence with Bells Fork. Downstream of pond on mainstem of Hughes Fork.	Inactive mining. Site is downstream of 8 valley fills.
* Indicates sites where Surber samples will be collected and continuous temperature will be recorded. Note that sites MT69 and MT81 are candidate “unmined” sites for Surber sampling in the Clear Fork watershed. Spring 1999 field work indicated both watersheds may be impacted by inactive mining. Alternate “unmined” sites in Clear Fork will be located during the Summer 1999 field work.				

D. Monitoring Parameters, Sampling Methods and Their Frequency of Collection

All field sheets used for this project can be found in Appendix B.

A station identification section and sketch of each site is completed in the field. The elements of the station identification that are completed in the field include: station number, water body name, location, date, time, county, state, reason for survey, investigators, agency, form completed by, estimated reach length, type of sampler, number of samples, sample number(s), mesh size, photograph numbers, weather conditions, and comments and observations. The other locational attributes are determined in the office using GPS files collected in the field, GIS and/or topographic maps. These attributes are descriptive (e.g. elevation, watershed acreage) and will not be used to determine the condition of streams. Upstream and downstream photos are taken at the sampling sites during each visit (Spring 1999, Summer 1999, Fall 1999, Winter 2000).

The station identification section and sketch field sheet is completed once during the project duration, unless changes are observed at the site on subsequent visits. If changes occur, a second sketch is completed to document the changes.

The physical habitat evaluation and the substrate size characterization require a 100 meter reach. The benthic sampling site is located at the mid point of the 100 meter reach unless the site specific circumstances require the reach be moved upstream or downstream slightly. For example, if a sedimentation pond is less than 50 meters above the benthic sampling site, the reach is "slid" downstream of the benthic sampling site so that the pond is not within the 100 meters. The reach might also be moved slightly to avoid changes in stream order within the 100 meters.

Semi-Quantitative Benthic Macroinvertebrate Samples

The macroinvertebrate population of the stream is sampled using the USEPA RBP single habitat sampling protocol (USEPA 1999). The sample is collected in riffle habitat only. A 0.5 meter wide, 595 micron rectangular dip net is used to collect organisms in a 0.25 square meter area upstream of the net. Four samples, each representing 0.25 square meters of riffle habitat, are composited. The total area sampled for each sample is approximately 1 square meter. The first sample is collected at the foot of the riffle, and subsequent samples are taken upstream, working toward the head of the riffle. Current velocity will be measured in the riffle where the benthic macroinvertebrate sample is collected.

The RBP single habitat protocol has been slightly modified to collect 1 square meter of substrate rather than 2 square meters. This modification was made because many of the streams sampled are very small streams, and we expect a fairly dry year. It could be difficult to sample 2 square meters of riffle habitat in some of the streams over the four seasons. We felt that a smaller sampling area would make it more likely that we could collect comparable samples over the four seasons. The 1 square meter sampling area still provides sufficient sampling area to make the assessment.

All boulders, cobble and large gravel within the 0.25 square meter area upstream of the net are thoroughly brushed to dislodge any clinging organisms. The rocks are brushed under water, upstream of the net, so that any organisms dislodged are washed into the net by the current. The rocks are removed from the 0.25 square meter sampling area after they are brushed. The remaining small substrate is then thoroughly disturbed by kicking the substrate for 20 seconds.

One-gallon plastic jars are used to hold the sample. A sampling label is filled out with pencil and inserted into the sampling jar. An example sample label is included in Appendix B. Each sample is assigned a unique sample number based on the date of sampling and the number sample for that day. (For example, the first sample collected on July 1, 1999 would be assigned a sample number of 07019901). The unique sample number is also noted on the field sheets for that sampling site. The samples are fixed with 100% ethanol, and transported to the biology lab in Wheeling, West Virginia by car, by the USEPA biologists who collect the samples.

Upon arrival at the laboratory, the samples are entered into a log book using the unique sample identification numbers. The sample is tracked through processing and identification, and the date when each activity is completed is also entered into the log book.

In the laboratory, the sample is deposited into nesting trays. The bottom tray holds water to float the sample. The top tray is fitted with a 30 mesh screen. The large debris are rinsed thoroughly and removed from the top tray. The sample is washed, floated, and evenly distributed in the nested trays. The top tray is lifted off the bottom tray, allowing the water to drain through the seive. This distributes the sample evenly on the seive. The seive has eight numbered grids. A number is randomly chosen and the portion of the sample on that numbered grid is removed from the seive and transferred to a white enamel pan.

This 1/8th subsample in the enamel pan is picked clean of all organisms. The sample is picked once thoroughly, and then transferred to another individual for a second thorough pick. The 1/8th subsample must provide a minimum of 100 organisms. If 100 organisms are not picked from the first 1/8ths subsample, an additional grid will be randomly chosen and another 1/8ths of the sample will be picked. If more than 1/8th of the sample is required to get a minimum of 100 organisms, the additional portion of the sample picked will be noted and carried through with the taxonomic data. The remaining unpicked portion of the sample is returned to the original sample jar and archived.

If the samples are identified in-house by EPA biologists, the organisms will be identified to the family level, except for worms and leeches which are identified at the class level. Taxonomic keys used for this project are listed in Section 12 (References). The Wheeling Laboratory also maintains a reference collection of benthic organisms for aid in identification. If funds are secured to contract the samples out, the organisms will be identified to the genus level.

Benthic macroinvertebrate d-net samples will be collected at all sites in four seasons: Spring 1999, Summer 1999, Fall 1999 and Winter 2000.

Quantitative Benthic Macroinvertebrate Samples

The quantitative macroinvertebrate samples are collected using a standard Surber sampler with a 500 µm multifilament nylon net. The sampler is placed on the stream bottom, ensuring that all sides of the sampler are flat on the bottom of the stream so that all organisms within the sampling frame drift into the net. All cobble and large gravel are brushed thoroughly and removed from the sampling frame. The substrate is then disturbed to a depth of three inches with the handle of the brush. Six Surber samples are collected at the sampling site and retained as individual replicate samples. Current velocity will be measured in the riffle where the benthic macroinvertebrate sample is collected.

One-liter plastic jars are used to hold the sample. A sampling label is filled out with pencil and inserted into the sampling jar. An example sample label is included in Appendix B. Each sample is assigned a unique sample number based on the date of sampling and the number sample for that day. (For example, the first sample collected on July 1, 1999 would be assigned a sample number of 07019901). The unique sample number is also noted on the field sheets for that sampling site. The samples are fixed with 100% formalin diluted with stream water so that the final concentration in the sample jar is 5-10% formalin. The samples are transported to the biology lab in Wheeling, West Virginia by car, by the USEPA biologists who collect the samples.

The samples will be held by the USEPA in Wheeling until funding is secured to process and analyze the samples.

Benthic macroinvertebrate Surber samples will be collected at six sites in four seasons: Spring 1999, Summer 1999, Fall 1999 and Winter 2000. The six sites are identified in Table 1. The six sites represent an unmined and mined site in three of the five watersheds. These sites were paired so that the mined and unmined sites represent watersheds of similar area and elevation. The paired sites are identified in Table 1.

Note that there are actually two candidate "unmined" sites in Clear Fork. Sites MT69 and MT81 were candidate unmined sites based on the advise of the WVDEP mine inspectors and the Streams Workgroup. Spring 1999 field work indicated both watersheds may be impacted by inactive mining. Ewing Fork had very high conductivity. Although the conductivity was low at the Sycamore Creek site, there is a mine drainage treatment plant in the headwaters, upstream of site MT81. However, we believe that Sycamore Creek is not affected by the mine drainage treatment plant as preliminary data indicate that the stream is in good condition. It is probable that MT81 will be retained as the unimpaired site to compare to the "mined site with valley fills" in Clear Fork, even though it will be classified as "mined" due to the presence of the mine drainage treatment plant.

Current Velocity

The mean current velocity will be measured in the riffle where the benthic macroinvertebrate samples are collected. The mean current velocity will be used to characterize micro habitats at different sites, created by different current velocities. The mean current velocity will be measured using a Marsh-McBirney MMI Model 2000 Flo-mate portable water flow meter and will be recorded in ft/sec in the Comments section of the field sheet.

Where adequate depth is present, the velocity measurement will be taken at 60% of the depth. The flow meter comes equipped with a top setting wading rod that is used to determine 60% of the depth and adjusts the sensor to that depth. Since most of the streams sampled will be very shallow, the velocity measurement will simply be taken in the deepest parts of the riffle where the sensor can be completely immersed. At least three velocity measurements will be taken from the foot to the head of the riffle sampled.

Physical Habitat Evaluations

The stream physical habitat is assessed using USEPA RBP protocols (USEPA, 1999). The habitat assessment is performed on a 100 meter reach that encompasses the biological sampling site. Some parameters do require an observation of a broader section of the catchment area other than just the sampling reach. The station identification section of the habitat assessment form is completed, making sure the attributes match the station identification field sheet.

Generally, it is best to perform all other work at the site first, including the biological sampling, the field chemistry measurements, and the substrate size characterization. The habitat evaluation requires walking the 100 meter reach, and can disturb the substrate. The biological sampling and substrate size characterization also provide good information to refine the habitat evaluation.

Parameters evaluated in the sampling reach include epifaunal substrate/available cover; embeddedness; velocity/depth regimes; sediment deposition; channel flow status; channel alteration; frequency of riffles (or bends); bank stability (condition of banks); bank vegetative protection; and riparian vegetation zone width.

Whenever possible, actual measurements are taken to make the assessment more quantitative. For example, the parameter “frequency of riffles” requires an estimate of the ratio of the distance between riffles divided by the stream width. We measure stream width at three locations within the 100 meter reach, calculate an average stream width, and calculate the ratio. The measurements make the habitat assessment more quantitative and less subjective. As another example, depth measurements are taken in riffles and pools throughout the reach to document the presence of different velocity/depth combinations within the reach.

The physical habitat evaluation will be performed once during the study period at all sites. If the physical habitat condition changes during the study period, an updated habitat evaluation will be performed.

Field Measurements of Water Chemistry

Dissolved oxygen, conductivity, temperature, and pH are measured in situ using a Cole Parmer

Check Mate Field Meter. The field chemistry measurements are taken directly upstream of the biological sampling site, before any disturbance occurs in the stream. The field chemistry parameters will be measured at all sites in each season.

Substrate Size Characterization

Substrate size characterization is determined using USEPA EMAP protocols (USEPA 1998). Eleven transects are measured over the 100 meter reach. The middle transect is located in the riffle where the biological sample is collected. Five transects are located upstream of the middle transect and five downstream of the middle transect. Each transect is evenly spaced (10 meters).

Substrate sizes are assigned to substrate classes (see Appendix B). Five measurements are taken at evenly spaced intervals across each transect (left, left middle, middle, right middle, and right). In other words, five particles will be randomly selected and measured in each of the 11 transects, for a total of 55 particle measurements. The 55 particle measurements will be used to determine the proportion of bedrock, boulder, cobble, coarse gravel, fine gravel, and sand and fines present in the reach. The 55 particle measurements will also be used to determine the mean particle size in the reach. Since the transects are evenly spaced, the riffle and pool habitat within the reach tend to be sampled in proportion to their presence in the reach. For example, if the 100 meter reach is 20% pool and 80% riffle, then the measurements will generally occur 20% of the time in the pools and 80% of the time in riffles.   If the 100 meter reach is 80% pool and 20% riffle, the measurements would be more representative of pools. Bankfull height, thalweg, slope, and wetted width are also recorded for each transect. Bankfull height is estimated using visual cues. Thalweg, slope and wetted width are measured directly.

The resulting fifty-five (55) substrate class measurements are used to estimate particle size composition and mean particle size.

The substrate size characterization will be performed once at all sites during the study period. If an obvious change occurs during the study period, an updated characterization will be performed to document the change.

Water Temperature Data Logger Measurements

Water temperature will be measured with a sampling interval of two hours using Optic StowAway temperature loggers. Two temperature loggers will be placed in stream at the six paired sites where the Surber samples are collected. Two loggers will be placed in stream to guard against loss of data due to high flows, vandalism, accident, etc.

The loggers will be placed at the sites during the Fall 1999 field work, flow permitting. They will be left in the stream for the duration of the study. The data will be retrieved semi-annually, during the spring 2000 and fall 2000.

E. Parameter Table

The following table describes the parameters that will be measured, the method of collection, the frequency of collection, and the preservative (where applicable). In Appendix A (Additional Monitoring Site Attributes), one of the attributes is described as "Indicator". The "Indicator" attribute can have two values: d-net suites or surber suite.

The term "d-net suite" is indicated for the 37 sites where the rectangular dip net benthic samples will be collected. Also included in the "d-net suite" are measures of current velocity, physical habitat evaluation, substrate size characterizations, in-situ field chemistry parameters (dissolved oxygen, pH, conductivity and temperature), and other additional water quality parameters (to be determined).

The collection of the additional water quality parameters will not be planned or collected as part of this study, and is not the responsibility of the Wheeling Field Office. It is our understanding that a separate QAPjP will be developed for the additional water quality sampling by the Corps of Engineers.

The term "surber suite" indicates the 6 sites where the surber samples will be collected. Also included in the "surber suite" are all of the measurements in the "d-net suite" plus the continuous temperature loggers. Again, the collection of the additional water quality parameters will not be collected as part of this study, and is not the responsibility of the Wheeling Field Office.

Table 2. Parameters Measured in the Field

Parameter	Method	Frequency of Collection	Sample Preservation
Rectangular dip net Benthic Macro-invertebrates	USEPA RBP Single Habitat Protocol 1999,. See description in Section D.	quarterly (Spring 1999, Summer 1999, Fall 1999, Winter 2000) at all 37 sites	100% Ethanol
Surber Benthic Macro-invertebrates	See description in Section D.	quarterly (Spring 1999, Summer 1999, Fall 1999, Winter 2000) at 6 of the 37 sites	5-10% Formalin

Table 2. Parameters Measured in the Field			
Parameter	Method	Frequency of Collection	Sample Preservation
Current Velocity	See description in Section D.	quarterly (Spring 1999, Summer 1999, Fall 1999, Winter 2000) at all 37 sites	not applicable
Temperature (EC), Dissolved Oxygen (mg/l), pH (su), Conductivity (uS/cm)	Cole Parmer Checkmate Field System at site, in situ. See description in Section D.	quarterly (Spring 1999, Summer 1999, Fall 1999, Winter 2000) at all 37 sites	not applicable, in situ
Stream Physical Habitat Parameters	USEPA RBP Protocols, 1999	once during study period unless changes occur at all 37 sites	not applicable
Substrate Size Characterization	USEPA EMAP Protocols, 1998	once during study period unless changes occur at all 37 sites	not applicable
Continuous Temperature (EC)	Optic StowAway Temp Logger. See description in Section D.	every 2 hours from the period October 1999 to October 2000 at 6 of the 37 sites	not applicable, in situ

9. Schedule of Tasks and Products

Table 3. Schedule of Tasks and Products													
Activities for period 4/99-4/00	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
Site selection	x	x											
Benthic sample collection	x	x		x	x		x	x		x	x		
Analysis of benthic samples			x	x	x	x	x	x	x	x	x	x	x
Data analysis and report preparation			x	x	x	x	x	x	x	x	x	x	x
Final report due to USEPA and Gannett Fleming when project completed													x

10. Project Organization and Responsibility

Environmental Services Division
Diana Esher, Deputy Director
Office of Environmental Programs
Rich Pepino (Office Director)
Jim Green (field and lab supervisor, sample collections and other field work, benthic identification, data interpretation, final reports)

Environmental Services Division
Diana Esher, Deputy Director
Office of Ecological Assessment
Charles App (Acting Office Director)
Margaret Passmore (QAPjP, sample collections and other field work, data interpretation, and final reports)

Signal Corporation

Hope Childers (database manager, data interpretation, GIS support)

11. Data Quality Requirements and Assessments

Benthic Macroinvertebrates

Quality control will be simplified by the same field team collecting the samples; the same lab technicians processing, subsampling and picking the sample; and the same biologists identifying the organisms. Any modifications to the protocol will be noted by field and lab personnel. Samples will be collected by Jim Green and Maggie Passmore or collections will be supervised by them. Jim Green will supervise and quality control all laboratory activities including sample processing, picking and taxonomic identifications.

Duplicate samples will be collected at 20% of the sites (8 sites). Duplicate samples will be collected at these eight sites in every season. If the eight sites can't be sampled due to low flow or no access, alternate sites will be sampled in duplicate so that duplicate samples are collected at 8 sites each season. This field duplicate will be processed as an independent sample in the laboratory.

The duplicates will be used to estimate precision of the sampling method. The estimate of measurement error includes error associated with field collections at the site and error associated with laboratory activities as well as true spatial variation in the benthic macroinvertebrate community presence at different locations in the riffle at the sample site. It is assumed that the variation of the benthic community within a riffle at one site will be much smaller than the variation in the benthic community between sites. Since it is not possible to separate the true variation in macroinvertebrate presence and density within the riffle at a site from the sampling error, this estimate of precision is not wholly composed of estimates of "measurement error".

To account for variance associated with measurement error in this assessment, we will estimate the standard deviation of the repeated measures. The standard deviation is calculated as the root mean square error (RMSE) of an analysis of variance (ANOVA) where the sites are the treatments in the ANOVA (USEPA, 1999). This estimate of measurement error will be used to determine whether individual sites are significantly different from a threshold or if they are different from other individual sites. It is not the main objective of this site to compare individual sites, but to compare the EIS Classes. This estimate of measurement error is only applicable to the comparison of single site measurements to other sites or to a threshold of impairment.

The sampling locations were selected to be representative of the stream EIS classes (mined with valley fills, mined without valley fills, and unmined) and were not located directly downstream of any pipes, discharges or other unusual conditions. The creeks sampled are generally higher gradient streams with a predominance of riffle habitat. The protocol helps to even out spatial variation at the sampling site because 4 separate 0.25 square meter samples are composited, so the sample is reflective of the entire riffle habitat.

Comparability in the methods will be handled by using consistent field and lab methods; the same field team to collect the samples; the same lab technicians to process the samples; and the same biologists to identify the organisms. Samples collected within the same watershed will be more comparable to each other because of their proximity (e.g. It is assumed that the stream arrays in the Mud River watershed will be more comparable to each other than stream arrays from different watersheds.). Samples collected within the same season will be more comparable because of seasonal variability between seasons.

Completeness is a quality assurance/quality control term and is defined as whether all samples that were planned to be collected are actually collected. Completeness will be judged on whether all samples can be collected. The limiting factors will be gaining access ahead of time, the weather, and flow limitations. The WVDEP mining inspectors are critical to gaining access to many of the sites which are on coal company property. In addition, it is very difficult to navigate on the MTR/VF operations because the topography has been substantially altered and the roads are not on available maps. We will require the assistance of the WVDEP mining inspectors in the field to gain access to many of the sites.

Samples will be collected at all sites unless the streams are dry or we can't gain access. If the riffle habitat in the stream can't be sampled due to dry conditions, we will not collect a sample in alternate habitat (e.g. pools). This condition will be duly noted and recorded as part of the study. The sampling plan calls for a Winter 2000 sample. Many of the sites are accessible only be four-wheel drive vehicle and may be impossible to access in winter.

It is critical that data be collected from both unmined and filled sites in each watershed in the same index period. The QAPP calls for sampling in four seasons, which will increase the possibility of collecting data at the unmined and filled sites in at least one sampling season.

12. References

Sampling Procedures:

USEPA. 1999. Revision to Rapid Bioassessment Protocols for Use in Streams and Rivers. Office of Water. Washington, DC. EPA 841-B-99-002.

USEPA. 1998. Field Operations and Methods Manual for Measuring the Ecological Condition of Wadeable Streams. Office of Research and Development. EPA/620/R-94/004F.

Taxonomic Keys:

Merritt, R.W., and K.W. Cummins (eds.). 1996. An Introduction to the Aquatic Insects of North America, Third Edition. Kendall/Hunt Publishing Company. IA. 862 p.

Peckarsky, B.L., P.R. Fraissinet, M.A. Penton, and D.J. Conklin. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press. NY. 442 p.

Pennak, R.W. 1989. Fresh-water Invertebrates of the United States: Protozoa to Mollusca, Third Edition. John Wiley and Sons, Inc. NY. 628 p.

Stewart, K.W. and B.P. Stark. 1993. Nymphs of North American Stonefly Genera (Plecoptera). University of North Texas Press. TX. 460 p.

Westfall, M.J., and M.L. May. 1996. Damselflies of North America. Scientific Publishers. FL. 650 p.

Wiggins, G.B. 1998. Larvae of the North American Caddisfly Genera (Trichoptera), Second Edition. University of Toronto Press. Canada. 457 p.

13. Sample Custody Procedures

Benthic samples will be supervised by one biologist (Jim Green) from sampling through processing and identification. The samples will not leave the possession of USEPA biologists from field sampling to organism identification. The samples will be logged into the EPA laboratory using a unique identification number. The sample will be tracked through processing and identification using that sample number.

If contractor funds are secured for taxonomic identification, then the samples will be labeled and tracked according to USEPA Region III protocols. This will include appropriate sample labels and chain of custody forms.

The samples will be stored in the benthic laboratory during the project. Once the samples are completed, the 1/8th subsample and the remaining 7/8ths of the samples will be organized by season and stored in a secured area with identification on the outside of the sample jars as well as labels inside the sampling jars.

14. Calibration Procedures and Preventative Maintenance

All instruments requiring calibration will be calibrated according to manufacture recommendations. Field measurements will be taken for temperature, dissolved oxygen, conductivity and pH using a Cole-Palmer Check Mate Field Meter. This meter will be calibrated each day it will be used in the field using appropriate pH buffers, conductivity standards, and zero oxygen standards.

15. Documentation, Data Reduction and Reporting

Field data sheets and taxonomic data sheets will be retained by the Wheeling Laboratory. The raw taxonomic data will be entered into a Lotus spread sheet to calculate metrics and into an ACCESS database for long term data management. The lotus spread sheet and the ACCESS database will be verified against the raw taxonomic list and field sheets.

16. Data Validation

Data transference is routinely checked and validated by laboratory personnel. Data entered into the computer will be routinely checked against the original field and laboratory sheets. Any problems will be documented, described and presented in the final reports. The project manager, as well as the other project staff, will perform this review.

Many of the streams may be very difficult to sample due to dry weather. Samples collected from stream sites that are difficult to sample due to extreme high or low flows may not be typical or representative of the true condition of the stream. These samples will be collected, processed, and analyzed, but they will be flagged, qualifying the results due to the difficult sampling conditions. The project officer will determine whether the data appear to be atypical or not representative of stream conditions, based on data collected at the same site in other seasons.

17. Performance and System Audits

The project manager will be responsible for the field and lab audits. He will be present during all field activities to observe and supervise the field crews and ensure they are following all of the procedures outlined in this project plan. The project manager will also make sure that the required number of replicates are being collected. Any problems will be addressed that day, in the field, and corrected to be in accordance with this project plan.

The project manager will make sure this project plan is followed in the field and in the Wheeling Laboratory.

18. Corrective Action

Repair and/or replacement of equipment and supplies will take place as needed.

Any changes to the original sampling plan will be documented in the final report.

Duplicate samples will be analyzed as soon as possible following sampling events to identify any problems with the field sampling protocols, laboratory protocols, or personnel.

19. Reports

The final report will include the results of the project, any QA/QC problems encountered during the project; changes in the QAPjP; and data quality assessment in terms of precision, accuracy, representativeness, completeness, and comparability. The final QAPjP will not be revised - any deviations from the original QAPjP will be reported in the final report.

The Project Officer will be responsible for the completion and delivery of the final reports. All EPA staff involved in the project, EPA contractors (Signal Corporation), and members of the PEIS Streams Workgroup will contribute to the development, findings and writing of the final report.

APPENDIX A. ADDITIONAL MONITORING SITE ATTRIBUTES

APPENDIX B. FIELD SHEETS